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AUTHOR Franz, Hans-Werner; And Others
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ABSTRACT

The steel industry in Europe has faced great changes, with resulting layoffs and restructuring. Now that the most basic changes seem to be over, it has become evident that the remaining steel industry requires more highly trained workers than was the case previously. Although steel maintenance employees were always highly skilled, steel production employees were usually semiskilled, learning their skills on the job in a narrow range of work and progressing in that category. For now and in the future, a new type of training for steel production workers is proposed. Workers would be expected to complete 10 years of mandatory schooling and then a 3- or 4-year training program in steel production. The training should include a broad base, lay the foundations for teamwork, and develop all-round skills. The following basic occupational training curricula would be developed: (1) skilled steel worker in process technology specializing in metallurgy, forming, or refining; (2) skilled steel worker in foundry technology specializing in hand mold casting or machine mold casting; and (3) metal materials test operator. (Detailed training requirements for these three occupations are listed.) (KC)

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CEDEFOP Document

Occupational profiles in the European steel industry

European Centre for the Development of Vocational Training

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Occupational profiles in the European steel industry

Hans-Werner Franz, Uwe Jürgenhake, Rainer Lichte
Sozialforschungsstelle Dortmund

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Jean Monnet House, Bundesallee 22, **D-W-1000 Berlin 15**
Tel. (030) 88 41 20; Fax (030) 88 41 22 22;
Telex 184 163 eucen d

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Foreword

This short expertise* has been prepared by sfs Dortmund on behalf of CEDEFOP to support the selection and definition of occupations, a task which is to be carried out in this sector by the experts of the Member States and by CEDEFOP itself in connection with the implementation of the Council Decision on the "Comparability of vocational training qualifications" (see EC Official Journal L199 of July 1985).

The analytical remarks presented in the expertise are likely to have parallels especially in those industries which depend very much on the steel industry such as the car and armaments industries.

We can expect the results in connection with the comparability procedure to be available in the first half of 1992. These will define which occupations together with their profiles will be given priority for the purpose of comparing state-recognised training qualifications, thus enabling employees to assert themselves more forcefully with regard to their qualifications and allowing enterprises, if they so wish, to recruit the qualifications they need from beyond their own borders or within the European Community.

Consequently it is not the aim of this expertise to press for occupations to be brought into direct line or even for them to be harmonized. This remains the responsibility of the Member States and the social partners within the framework of their autonomy. Nevertheless, the expertise might help them arrive at decisions.

Burkart Sellin
CEDEFOP, Berlin, December 1991

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* This expertise is based on a comparative study commenced in 1987 on trends in training requirements in the European steel industry. See Franz, Hans-Werner; Lichte, Rainer: Qualifikation für Qualität. Studie über die Bedürfnisse der beruflichen Bildung in der europäischen Eisen- und Stahlindustrie (Qualification for quality. A study on the needs of vocational training in the European iron and steel industry), pub. by the Commission of the European Communities, GD V, Brussels/Luxembourg, 1991; abridged versions will presently be available in English, French, Italian and Spanish in addition to the unabridged German edition.

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Structural Change in the Crisis

The rapid modernization of the steel industry during and as a result of the crisis since the mid-1970s has made fundamental changes in the vocational qualifications of those employed in the industry necessary. There are three main trends which will continue to have an impact in the future:

1. While the redundant capacity crisis and the structural changes linked to it seem to have been overcome on the whole, the technical and organizational rationalization process is still in full swing. Further efforts to automate (CIM) and the rationalization of processes (e.g. strip casting) will in all likelihood ensure its continuation or even acceleration through the 1990s. These developments will establish the need for much higher qualifications not only because of technical change but also as a result of the related organizational changes in companies.

2. The steel industry in the developed industrialized countries has changed in quality as a result of the crisis. Steel has become a highly differentiated product that must prove itself on a market controlled by customers' requirements. In a market determined by price and (perhaps even more) product quality, reliable delivery (just-in-time), after-sales service and innovative capacity, and with massive automation playing a vital role, production conditions in the steel industry have been revolutionized. Apart from maintenance and servicing, more and more often human labour is "only" running, controlling and optimizing

processes with the help of electronic data processing systems in measuring stations and control rooms. Higher requirements with regard to product quality and flexibility within the overall organization of a company not only cast doubt on the traditional form of vocational training in production (training on the job) and the increasing degree of overlapping in job profiles in the maintenance sector, it also questions the conventional ways the work is organized.

3. Heightened competition with non-European suppliers will do its part in prolonging and speeding up the race to rationalize. The technical standard of production facilities will tend to play a less and less vital role in this process since state-of-the-art machinery can be bought comparatively easily in the transfer of know-how. The crucial factor will tend more and more to be whether management succeeds in orientating the overall organization of a company to the new requirements. The prerequisite for this will be to train and use virtually every employee and the entire staff in such a way that they - each member as an individual and the staff as a whole - are also willing and able to fulfil the high practical and processing requirements expected of steel as a product.

This background, which applies to numerous other sectors as well, sets the steel industry very special tasks since the vast majority of those employed in production have at their disposal only practical skills and knowledge that are closely related to their respective work place. In view of the changed and still changing requirements, semi-skilled workers, and they in

particular, also need constant continuing training.

Excursus: Semi-skilled key workers in steel production

Regardless of national or cultural borders, the qualifications structure of staff employed in the mills of the steel industry has a common basic pattern: Production work and the work performed by maintenance and servicing personnel are sharply divided, and the value placed on the formal qualifications of those employed in these two areas differs considerably.

Production work is traditionally performed by staff commonly known as semi-skilled workers. This is the case in all the steel works we surveyed in Western Europe. Although the idea of creating a production occupation was mooted in some countries in the 1930s, these considerations only bore fruit from the 1960s onward, and then only in a minority of the countries we visited. Even in the early 1960s, coastal steel works went into operation with "green labour" (fishermen, farmers, etc. lacking industrial and trade union experience).

These semi-skilled production workers have often completed a proper course of vocational training but being unable to find comparably paid work, they then switch to the steel mills. They end up in departments which have an extremely hierarchical structure and high division of labour. They are trained on the job by their more experienced workmates (the buddy system) for the various individual work places. Usually they learn to operate only one set of machines or a limited area of work. Over a long period of time, they slowly rise to the top positions in

these work structures, usually in the area in which they began.

In contrast to this, in maintenance and repair and in many service and ancillary facilities, we find almost without exception skilled workers. They have been given a three- or four-year apprenticeship, which is the norm in most European countries, to train them specifically for their duties in these areas. And they receive - sometimes even systematically - continuing vocational training much more frequently than their semi-skilled workmates in production. In these areas companies have found tried and tested solutions which suffice on a long-term basis to establish the necessary qualified manpower, even though these areas may at times be afflicted with temporary training deficits (when introducing new techniques, for example).

The structure of the workforce in the field of production work is an area that is unanimously seen as becoming more and more of a problem (even if all companies do not draw the same conclusions with regard to training measures). The reasons for this are obvious:

a. The thinning out of staff and tighter work schedules no longer guarantee successful on-the-job training in the buddy system;

b. Production work (and thus its directly learnable contents) is becoming less and less transparent while abstract systems knowledge on process and control technology for computer-aided production has become essential;

c. The accelerated pace of technological change demands increased in-company mobility. This cannot be attained without friction unless the staff has a basic general knowledge of the technical and organizational processes in the steel industry;

d. The new imperative of steel production is quality - and in view of cost pressure, quality can no longer be achieved by end-of-line testing and control of the final product. It must be the result of qualified production work, which therefore assumes the employment of qualified production workers.

One other circumstance aggravates the situation: During practically the entire duration of this structural crisis which has lasted more than 15 years, all companies stepped up early retirement at 55 (sometimes even at 50) within the framework of social plans as one way of cutting down on staff. These employees left the companies at the height of their accumulation of experience, even though they may have passed the peak of their physical performance ability. They took their experience with them, leaving the companies bereft of a substantial supply of experienced workers with specific qualifications, which was hard to compensate through young semi-skilled workers.

Trends: Steel workers in the year 2000

In this situation in which the buddy system has become increasingly obsolete due to staff cuts, technical developments and free market constraints, companies have tried out a wealth of various measures that, although initially unintended, have also lead virtually everywhere to thoughts on developing an occupation, at least in strategically important positions, for production work.

In general it can be said that today personnel departments in companies are demanding higher average educational qualifications when recruiting new staff than was the case a few years ago. In addition to this, an abundance of individual measures has been developed in companies to upgrade the qualifications of their staff and to secure these qualifications for the future. These measures have often been of an ad hoc nature; frequently different solutions have been tried out in different areas with little or no coordination. An overall personnel policy strategy reaching to all corners of the company could be identified in individual cases at best. A summary of the approaches to solutions in the various companies can be more or less grouped as follows:

1. Everywhere without exception insistent efforts were being made or were already extensively implemented to systematize the training of production workers. This systematization of semi-skilled training was generally started in the 1970s but it was boosted through the massive cuts in staff and resultant transfers. These steps to systematize semi-skilled training usually relied on manuals related to

systems and jobs or the like. They provided the basis for a uniform step-by-step approach to learning segments which initially were to enable employees to extend their field of activities within the framework of climbing the hierarchical ladder on specific installations.

2. In recent times and to an increasing extent, attempts to systematize semi-skilled training are being enriched by training stages conducted away from the job. Catching up on training is becoming an important element of continuing training. Considerable efforts are being invested in adapting teaching and learning forms as far as possible to the working conditions (e.g. shift work) and the personal learning needs (no systematic learning over many years, inadequate school background) of the target group.

3. The first approaches to provide vocational training for production workers are frequently forms of "semi-skilled training": a combination of systematic basic training in the first "apprenticeship year" (sometimes outside the production as well) and systematic semi-skilled training on the job building on this. The experience and elements of the basic training of skilled workers are also being used more and more often for training production workers. Sometimes both these groups are trained together.

4. In virtually all countries the medium-term prospects are: skilled worker training for production work. As an intermediate solution, within the framework of recruitment policies and personnel planning, companies are manning new installations with skilled maintenance workers who cannot

be offered jobs in the occupation for which they have trained after sections of the plant have been shut down or after they have completed their training. However, some companies have also set their sights on catching up on (skilled) training for production workers. One company is even endeavouring to have all its workers trained as skilled production workers (within the next six years).

5. Restructuring the organization and to a great extent also the contents of the entire initial and continuing training system may be considered the most comprehensive measure in this field. What is to be achieved is the step-by-step introduction of a skilled worker course of training for production workers and a completely overhauled training course for skilled maintenance workers in the sense of an integration of occupations. In this way, the impulses for far-reaching work-organizational changes will be processed in the education systems of individual plants. At the same time, restructuring initial and continuing training is for its part to accompany and prompt further changes in work structures in the remaining sections of the mills.

While all firms see the need to take semi-skilled workers more into account in in-house continuing training, especially in catch-up courses, transferring this knowledge into practice comes up against many and diverse barriers[2]. In our opinion, equal

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[2] The overall workforce must always be kept larger by that percentage of the staff engaging in initial or continuing training, for example. This realization does not seem to be common knowledge among company cost accountants.

opportunities for all seem to demand it.

The production and processing of steel in the future will be carried out by small, highly qualified and highly integrated teams made up of members drawn from different interdisciplinary skilled worker occupations cooperating together. They will need broad-based, diversely implementable and transferable training and constant further training to cope with the problems of rapid technical change and fast changing production requirements. Cognitive abilities are becoming more and more important in comparison to manual skills. The main requirement made of the steel worker of the future will be to make independent, accurate, pertinent and fast decisions in an interdisciplinary team and to solve problems with a high level of competency and efficiency.

Improved initial and continuing training, and broader-based and higher qualifications will achieve little so long as work place structures are kept constricted and inflexible. Qualifications which are not sufficiently utilized at the work place become passive and are forgotten. Valuable knowledge and skills - and with them not least, expensive investment in training - remain unused, deteriorate. It is only through measures aimed at active job structuring and involvement that this danger can be minimized long-term and the created potential maintained and developed. Without effective forms of involving employees and those representing their interests there is a risk that such organizational innovations will find expression in increased stress, strain and conflicts. If the steel industry is to become attractive again in the future to young, well-trained people - and as a result of the crisis it has lost much of its previous standing in all countries - it will have to take pains to make

the work more interesting if only for the fact that expectations with regard to job satisfaction have changed.

This indicated change also demands that far-reaching changes be made in traditional teaching and learning forms: active learning, working out solutions to problems independently, both individually and in teams, cooperative, project-oriented learning; these are terms which suggest at least how the process of acquiring specialized and social competences in companies might be designed and is already in practice in many places.

Company organization geared to quality production, flexibility, and commitment in after-sales service must demand independence, responsibility, an orientation toward problem-solving, initiative, and a willingness and ability to engage in active communication from its workforce; it must also enable its staff to acquire these skills. The demand for higher qualifications is therefore linked to work organizational conditions in which these qualifications can be developed but also ones which can be modelled by the qualified in their interests.

At company level, process- and product-oriented organizational forms are replacing conventional functional organization. The former are more in line with the requirements of make-to-order production in small batches which currently prevails. In many places less predominant hierarchical structures, more highly integrated forms of work organization, sometimes even fully integrated team work can be found. They are not only in keeping with the changed requirements made of the companies. They are also a necessary answer to the improved qualifications of many on the workforce. Highly qualified employees must be motivated,

not commanded. They demand more open work and decision structures. Such structures assume for their part also better trained employees with developed social competences, however.

Euro-profile: Contours

In view of the changed qualification requirements outlined above and bearing in mind the diverse developments which have taken place in the field of vocational training of production workers in the steel industry in various countries (the Netherlands, Great Britain, Germany, France and in parts of Spain), we propose that a "Euro-profile" be developed in the following direction for the steel industry:

The occupational profile of a skilled production worker in the steel industry should be as broadly based as possible to enable employees to be mobile both of their own accord and as a result of anticipated restructuring in the industry. At the same time practical experience in all countries has shown it is evidently not sensible to deal with the entire spectrum of jobs within the steel industry in one occupation since the time and effort spent on specializing in the company after completion of training would then be too great. According to the discussions covered by our survey, it would seem sensible to differentiate according to occupations for process technology and materials science while all experience suggests differentiating between the type of company within the process technology occupations - steel production or steel processing - and within steel processing, differentiating again according to processing sections.

Following this pattern we arrive at the following basic occupations:

1. Skilled steel worker in process technology specializing in:
   - Metallurgy
   - Forming
   - Refining.

2. Skilled steel worker in foundry technology specializing in[3]:
   - Hand mould casting
   - Machine mould casting.

3. Metal materials test operator.

In view of the increasing complexity of the technical aggregates and the growing degree to which skilled work is being integrated in production in the steel industry, at least 3 years training following successful completion of 10 years compulsory schooling at a general education school is necessary for all the above-mentioned occupations.

The following common features should apply to all the occupations:

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[3] A decision on sub-categories would have to be made depending on the structure of the vocational training system. The classification proposed here is based on a dual training system in which the training enterprises are either very small (hand mould casting) or mass production manufacturers (machine mould casting) and each would have trouble providing training in the respective other specialization area.

- The training will commence with a broad-based foundation in materials science and the skills of how to work materials. Only at a relatively late stage will the respective areas of specialization be given more attention.

  This general training period will be used to teach skills and knowledge such as:
  - Materials and auxiliary materials and important processes for working them: cleaning, cutting, joining;
  - Handling and maintaining work materials, tools and equipment;
  - Making and reading technical drawings;
  - Testing, measuring, marking, graining, lining out;
  - Clamping, chucking, fixing and aligning;
  - Planning, checking and rating;
  - Fundamental control and regulation technology: pneumatics, hydraulics, electronics.

- The basic training must lay the foundations for teamwork with other occupational groups, e.g. in joint training stages especially with trainees in maintenance occupations whose jobs in the company will become more and more interlinked with production work. This cooperation must be integrated into the entire course of training, far beyond the basic training.

- Throughout the entire training, focus will be placed on knowledge which has no specific bearing on the course (i.e. all-round skills) and is applicable to

all occupations. What is meant here are such things as:

- Foundations of vocational training (rights and obligations arising from the training contract);
- Social organization of the business and undertaking (how it is organized and operates, company and trade union interest representation, etc.);
- Labour law and collective bargaining law;
- Job protection, health protection and on-the-job safety;
- Environmental protection, production geared to conserving resources.

In view of the different vocational training systems in practice in Europe, no general statements can be made on the time structure, the way training is organized, the choice of learning locations or methodological-didactic principles. Nevertheless, we did find in all countries a strong tendency to draw initial vocational training close to companies with the obvious argument that it shortened the subsequent period of familiarization in the company.

Profile 1: Skilled steel worker in process technology

Within a company the field of work of the skilled steel worker[4] in process technology[5] is the whole production process of steel production and working, from mineral parks and sintering plants to surface treatment plants and finishing shops. He supervises and controls the extensively mechanized and automated production facilities from centralized measuring stations, control rooms and control platforms. He controls and evaluates the manufacturing processes so that he can intervene and regulate as necessary, avert breakdowns or keep them as brief as possible.

He optimizes the manufacturing process, working in close cooperation with superiors and maintenance workers and those departments and enterprises directly or indirectly involved in the production of the products such as the manufacturing planning department, quality control, maintenance and transport departments.

His work demands a willingness to assume a high degree of responsibility. Top of the list is on-the-job safety - his own

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[4] When we subsequently use the male form to refer to this and other workers, this is done for reasons of linguistic simplicity only. Of course women may work in these jobs as well - and in some steel works we saw a few too. Much water will pass under the bridge before women are found in steel production as a matter of course.

[5] It would also be conceivable - as we saw in the Netherlands and for academic professions in Great Britain - to have a common training stage with other process technology occupations such as with the chemical, textile and food industries.

and others. Apart from that, he works on technical facilities, the investment costs of which run into the millions and the technical-physical processes of which are sometimes only known roughly and can only be depicted with incomplete models in the displays and computers in the control rooms. In other words, in this zone of uncertainty he must keep and maintain the values of the technical equipment entrusted to him, which ensure the customer receives the quality he requires and that the operating equipment, materials and energy are used optimally. Over and above this, he shares responsibility for protecting the environment - the water, the soil and the air - while engaging in the manufacturing process and storing waste products.

It would certainly be too lengthy and unsatisfactory for all involved if one were to train the skilled steel worker in process technology for the whole process of an integrated smelting plant including steel-related further processing. Working conditions and job requirements in the different companies are too varied for that. We therefore propose that after a sound broadly based fundamental training in materials and process technology, the last stage of training should be allowed to lead into one of three areas of specialization.

The common fundamentals would be more or less:

- Basic techniques of metallurgy and forming;
- Metallic materials, heat treatment, material testing;
- Forming (rolling and milling, rolling mill equipment, forging, etc.);
- Joining, soldering, welding;
- Material flow, production and process control by hand and

by means of electronic data processing, using information techniques/technologies;

- Fundamentals of running and maintaining production facilities.

In the final stage of training, in keeping with the three different areas of specialization, the following skills and knowledge are the minimum requirements of the vocational training:

1. When specializing in metallurgy:
   Job and environmental protection specific to the area of specialization, preparation and storage of the materials to be used, metallurgical production processes and installations, fundamentals of forming and refining steel, maintenance of production facilities;

2. When specializing in forming:
   Job and environmental protection specific to the area of specialization, fundamentals of metallurgy and refining steel, preparation and storage of the raw material, manufacturing processes, installations and tools for forming steel, products and quality assurance, maintenance of manufacturing facilities;

3. When specializing in refining:
   Job and environmental protection specific to the area of specialization, fundamentals of metallurgy and refining steel, preparation of the raw material, surface treatment: processes, installations and materials, products and quality assurance, maintenance of manufacturing facilities.

Profile 2: Skilled steel worker in foundry technology

The skilled steel worker in foundry technology makes moulds and cores (for forming the interiors in work pieces) according to patterns from heat-resistant moulding material. These moulds and cores are filled with smelting metal. They are removed after the cast piece has cooled, being either destroyed in the process or stored for re-use as permanent dies (usually made of steel) for producing a large number of cast pieces.

The skilled steel worker in foundry technology operates all the production equipment in this process: melting furnaces[6], pouring lines, mould stands and machines, core machines, transport and cleaning equipment. He carries out inspections on this equipment and services it in accordance with servicing schedules. He does simple repair work and operates ancillary equipment. His work also involves choosing the right tool, testing and measuring equipment for the job and the required machines. Making sketches and bills of materials in keeping with a standard form, establishing work steps and using tables, illustrations, manuals and operating instructions are just as much a part of his job as is performing necessary tests and controls.

This skilled worker must also be familiar with production control during operations, material flow e.g. of mould materials, cores, and liquid metal, measures to control manufacturing and quality assurance and with data processing, which is commonly used these days.

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[6] A skilled steel worker in process technology specializing in forming might work in the field of smelting also.

In the initial training stages, the training for this multi-facetted and - especially with regard to job safety - highly responsible occupation is quite similar to that of the skilled steel worker in process technology. What distinguishes it from the latter are the following skills and knowledge specific to foundry work:

- Fundamentals of moulding, melting and casting;
- Melting technology;
- Melting and holding installations;
- Moulding and casting tools;
- Gating and feeder technology;
- Production processes, material flow, production control by hand and by means of data processing;
- Mechanical core mould processes;
- Casting;
- Aftertreatment of cast pieces;
- Cast control, fault detection and prevention of faults;
- Material testing;
- Fundamentals of maintenance of production installations.

Only in the final stage of training does the course differentiate according to whether trainees are specializing in hand mould casting or machine mould casting. This depends mainly on the fact that the enterprises in which the training is being conducted normally specialize in one of these moulding processes.

The companies producing single piece or small series[7] often only have hand moulds while moulding machines are used for medium-sized and large series[8]. In other words, the practical training will depend on what equipment the company can put at its trainees' disposal.

The following minimum skills and knowledge should be part of the training in the specialized area:

1. When specializing in hand mould casting:
   - Job protection specific to the area of specialization;
   - Moulding materials for moulds and cores;
   - Production of moulds;
   - Production of cores;
   - Mechanical moulding processes using mechanical compression;
   - Moulding processes using chemical and physical setting.
   - Casting

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[7] These may be very large and heavy cast parts such as machine tool stands. Other enterprises, e.g. in the area of art casting, will often cast small, light cast pieces requiring close attention to design and surface quality. Casting materials out of iron and non-ferrous metals are worked.

[8] Such cast pieces are used in practically all industrial sectors but principally in the motor vehicle and building industries. Examples of such cast products are cylinder blocks, crankshafts, brake-discs, cast parts for sewers, and precision parts such as turbine blades for aircraft motors.

2. When specializing in machine mould casting:
   - Job protection specific to the area of specialization;
   - Moulding materials for moulds and cores;
   - Using and consolidating the basic techniques of moulding and casting;
   - Mechanical moulding processes using mechanical compression for clay-bound moulding sand;
   - Moulding processes using chemical and physical setting;
   - Mechanical core moulding processes;
   - Fundamentals of running production installations;
   - Operating and supervising production installations.

Profile 3: Materials test operator

A materials test operator carries out mechanical, technological and physical tests on various materials. They may well be employed outside the steel and foundry industries (in the plastics or ceramic industries, for example). In these industries the materials test operator may be employed in any of the departments dealing with quality assurance and control. He might also be employed in research departments, in the processing of complaints or in customer service.

In the steel industry, too, he will be employed in material development, production and processing to ensure, check and improve the technical quality of the product. He will of course

need comprehensive knowledge of materials science and testing procedures (which are generally standardized). Consequently, his work will focus on two main areas:

- Taking and preparing samples in keeping with standard procedures
  and
- Examining and evaluating samples in accordance with different testing procedures.

We propose that the structure of training for the materials test operator is similar to that suggested for the above-mentioned occupations. This means focus will be placed in the initial training segments on knowledge which has no specific bearing on the course (i.e. all-round skills) and is applicable to all occupations.

When it comes to the specialized contents, there is also some overlapping with process technology and foundry technology courses, making it possible to have common training stages for all trainees in these occupations. What comes into this category would be for example:

- Basic skills and elementary knowledge in metalworking (e.g. filing, chiselling, sawing, drilling, countersinking, thread cutting by hand);
- Measuring, testing, marking;
- Reading and preparing technical drawings;
- Basic knowledge of electrotechnology.

The training will consolidate the above and support it with additional specific skills and specialized knowledge such as:

- Recording melting and solidification curves;
- Carrying out different forms of heat treatment;
- Grinding and polishing metal samples for metallographic testing;
- Etching for macroscopic and microscopic tests;
- Establishing hardness in accordance with prescribed methods;
- Carrying out breaking, bending, notched-bar impact and indentation, etc. tests;
- Learning and using non-destructive material tests;
- Caring for and maintaining tools, apparatus and equipment;
- Basic training in quality areas (e.g. metallography, hardening shop, electron microscope);
- Basic knowledge of quality control and process technology;
- Specialized training in all departments where a materials test operator would normally work.

CEDEFOP — European Centre for the Development of Vocational Training

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Hans-Werner Franz, Uwe Jürgenhake, Rainer Lichte
Sozialforschungsstelle Dortmund

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